RESIDENT WILDLIFE RESPONSES TO DISTURBANCES PRODUCED BY THE CANOL CRUDE OIL PIPELINE PROJECT, N.W.T., 1942-1945

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ABSTRACT

The CANOL crude oil pipeline project which has been abandoned since 1945 caused a number of environmental impacts associated with road, false start road, bladed trail, camp yard, bulldozer track, gravel pit, gravel pit access road and oil spill disturbances. In Alpine tundra resident wildlife use of the new habitats produced by these disturbances indicates that they are often more frequently used than adjacent undisturbed areas. Small mammal numbers on disturbances declined or were equal to that of undisturbed areas. Camp yard, gravel pit, road and oil spills had the greatest declines.

Woodland caribou, Dall's sheep, arctic ground squirrel and Ptarmigan use increased on most disturbances. Declines in moose use were noted for most disturbances. Trends in the data indicate that, depending on the species of wildlife, linear disturbances provide greater ease of movement, and/or greater protective cover, and/or preferred forage.

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The CANOL Project was a World War II venture commissioned by the United States (U.S.) Army but engineered, designed, constructed and operated by civilian contractors from the U.S., employing both American and Canadian labourers. The objective of the Project was to transport crude oil from producing wells on the Mackenzie River at Norman Wells in the Northwest Territories (then the northermost producing oilfield on the continent) to Whitehorse in the Yukon Territory (Figure 1). The oil was to be refined in Whitehorse and the finished products transported by pipelines to Carcross and Watson Lake in the Yukon and to Fairbanks and Skagway in Alaska. The refined products would then be available for the defense of Alaska and Canada against the Japanese and for the fueling of aircraft being flown to the U.S.S.R. as part of the lend-lease agreements (Richardson 1944a).

The CANOL Project (Figure 1) entailed the construction of a 10.2 cm diameter, 737 km long crude oil pipeline from Norman Wells to the Alaska Highway at Johnson's Crossing and a 15.2 cm diameter, 192 km long pipeline from that point to Whitehorse. From Whitehorse, 5.1 cm and 7.6 cm pipelines dispersed products to the locations mentioned above (Figure 1). A total of 2,575 km of pipelines in four separate systems eventually were constructed as well as 828 km of gravel-surfaced tote road, 829 km of telephone system, 2,415 km of primarily new winter roads, ten landing strips along the Mackenzie River (U.S. Army 1950) and 58 wells of the 55 produced commercial quantities of oil (U.S. Army 1950). In addition to this, 2,736 km of water routes were upgraded (Finnie 1945) (Figure 1). Construction began in October 1942 and the Whitehorse refinery commenced operations on 30 April 1944. The total Project cost was $138,000,000 1942-1943 dollars (Truman Hearings 1944), exceeding that of the Alaska Highway. Several Projects were carried out within CANOL and most of these involved air routes and winter roads.

Only the Northwest Territories sections of the CANOL No. 1 pipeline, road and associated telephone system were considered in this study. This section of the

Note For detailed view of pipelines see following page

Figure 1 Northern Canada and Alaska, joint defence construction projects, 1944

Territories section of the CANOL Project. The first inventory in 1944 included reports on mammals (Rand, 1945) and birds (Rand, 1946). The second included only the large mammals (Gill, 1978). These reports provide inventories of species present in the area but do not discuss the effect of the CANOL Project on resident wildlife.

Little information is available in the literature regarding the long-term effects of disturbances in their abandoned state on northern wildlife. Douglass (1977) and Riewe (1979) working with small mammals, concluded that the habitat resulting from seismic line construction below timberline was preferred by meadow voles (*Microtus pennsylvanicus*) but not by boreal red-backed voles (*Clethrionomys rutilus*). Both studies were completed in forested sites with Douglass studying a winter road and Riewe working on bladed trails and seismic lines. Riewe's studies of disturbances, that were one to six years old, showed an overall decline in small mammal numbers (1979).

METHODS

The data presented below are derived primarily from the 1979 summer, and to a lesser extent, from the winter field seasons. Observational data were collected throughout the study. In addition to this, trapping and transect studies were completed in areas that had previously been sampled for vegetation and substrate information. A sample site included disturbed and undisturbed or 'control' habitats. The control results were used as a datum for comparison with disturbance data to determine the magnitude and direction of change effected after 35 years (i.e. control-corrected values).

Disturbances included: 1) the Canol Road; 2) roads that were started but never finished; 3) bladed trails that peeled back the soil surface layer(s); 4) the yard area associated with permanent camps; 5) tracks produced by bulldozer treads when blading was not done; 6) gravel pits; 7) gravel pit access roads; and 8) oil spills.

Small Mammal Traplines

Small mammal traplines were established and maintained over three trap-nights at each site. It was not possible to fit a large number of traps into the more localized disturbances such as oil spills and bulldozer tracks. Many of the disturbances studied were linear and did not cover a broad area. Consequently it was decided to use a trapline rather than set traps in a grid pattern. Each trapline consisted of 14 Woodstream Museum Special snap traps bated with a mixture of peanut butter, oatmeal and bacon fat. Lines were limited to 14 traps for two reasons. First, many of the disturbances covered relatively small areas and could not accommodate large numbers of traps. Second, camp was moved every three days which involved backpacking all food and equipment for distances of up to 35 km. All lines were placed through the centres of disturbances in order to minimize the edge effect and each was checked twice daily, in early morning and late evening. Trapped animals were sexed, measured and weighed and the skulls and skins were retained for final identification.

Wildlife Sign Transect Methods

A belt transect 2 m wide and 65 m long was set up at each site. Within this area droppings (i.e. individual scats or pellet groups), tracks and other signs were identified and counted. In all cases, the transect ran through the centre of the area under study and included as many of the available microsites as was practical while still remaining representative of the general area. Usually, the belt transect paralleled the trapline and included the previously sampled vegetation quadrats.

RESULTS

Fifteen species of mammals were observed during the course of the study. Seven species of small mammals were trapped:

Red-backed vole (*Clethrionomys rutilus*)
Varying lemming (*Dicrostonyx torquatus*)
Long-tailed vole (*Microtus longicaudus*)
Meadow vole (*M. pennsylvanicus*)

Least chipmunk (*Eutamias minimus*)
Pika (*Ochotona princeps*)
Heather vole (*Phenacomys intermedius*)

The following four species of birds were taken in the traps:

Water pipit (*Anthus spinoletta*)
Baird's sandpiper (*Calidris bairdii*)
White-crowned sparrow (*Zonotrichia leucophyrus*)
Lapland longspur (*C. lapponicus*)

Evidence of the following eight mammals also was noted:

Moose (*Alces alces*)
Wolf (*Canis lupus*)
Siberian lemming (*Lemmus sibiricus*)
Dall's sheep (*Ovis nivicola dalli*)
Woodland caribou (*Rangifer tarandus caribou*)
Arctic ground squirrel (*Spermophylis parryii*)
Grizzly bear (*Ursus arctos*)
Red fox (*Vulpes vulpes*)

Much evidence of Willow and Rock Ptarmigan (*Lagopus lagopus* and *L. mutus*) was found in the study area but it was not possible to distinguish between these species on the basis of sign alone.

Small Mammal Trapline Results

A total of 121 traplines were run with 42 trap-nights at each site. One site had only seven traps for a total of 21 trap-nights because of space limitations. Twenty eight traplines were control sites. Twenty nine small mammals and thirteen birds were taken over 5061 trap-nights. This gives a very low success ratio of 0.83 animals (including avifauna) or 0.57 small mammals in 100 trap-nights (Table 1).

Two major factors contributed to the extremely low trapping success. Firstly, small mammal populations were low and secondly, traps were often triggered by animals, hail or heavy rain and therefore were not effective if visited subsequently by small mammals. Ground squirrels were the major culprits when traps were found sprung, since they were often numerous, were attracted to the bait and were too large to be captured. Traps sprung and then robbed of bait accounted for 107 trap-nights. On four occasions, 100 percent of the traps in a line had been tripped and

TABLE 1

LONG-TERM RESPONSES BY SMALL MAMMALS TO DISTURBANCES
INITIATED BY THE CANOL CRUDE OIL PIPELINE PROJECT, N.W.T. 1942-1945

Site type	No. of trap lines	Varying Lemming	Least Chip-munk	Red-backed Vole	Long-tailed Vole	Meadow Vole	Heather Vole	Pika	Avifauna	Success rate in 100 trap-nights All animals	Success rate in 100 trap-nights Small mammals	Effective trap-nights
Control	28	3		5	1			1	2	1.12	0.93	1,073
Road	28	2		2				1	6	1.09	0.50	1,008
False Start Road	3			1						0.80	0.80	125
Bladed Trail	14			5					1	1.11	0.92	541
Camp Yard	1									0.00	0.00	35
Bulldozer Track	9			3						0.92	0.92	327
Gravel Pit	24			1					1	0.21	0.11	947
Gravel Pit Access Road	9		1	1			1		3	1.70	0.85	353
Oil Spill	5					1				0.50	0.50	201
Totals	121	5	1	18	1	1	1	2	13	$\bar{x}$=0.91	$\bar{x}$=0.63	4,610

robbed. Ground squirrels were frequently observed stealing bait. A total of 344 trap-nights were lost with no bait robbery during the course of the study. On eleven occasions more than 75 percent of a trapline was tripped by rain or hail. Altogether, 451 or 8.9 percent of the total 5061 trap-nights were lost. If the success rate is recalculated, subtracting this number from the total trapping nights, it would be 0.91 animals or 0.63 small mammals each 100 trap-nights (Table 1).

The values presented in Table 1 take all of the lost trap-nights into consideration. Based on the corrected values for all animals, trapping success rates on controls were only slightly higher than those of bladed trails, roads and bulldozer tracks (Table 1). Gravel pit access roads had approximately 50 percent higher success rates than were recorded for controls. Small mammal trapping success rates were highest and approximately equal on controls, bladed trails and bulldozer tracks (Table 1). Lowest success was found on the camp yard site (0.0 percent) and in gravel pits (0.11 percent). Success rates on road and oil spill sites were equal and slightly below average while those of false start roads and gravel pit access roads were well above the mean (Table 1).

Wildlife Sign Transect Results

A total of 132 transects were run, including 33 control sites. The presence of Ptarmigan, grizzly bear, red fox, wolf, woodland caribou, moose, Dall's sheep, arctic ground squirrel, pika, and other small mammals was noted in the transects through signs such as pellet groupings and tracks. There was also evidence of small mammal activity in many areas. The most common large mammal was the woodland caribou, with sign on 56 transects. Least common were the red fox and the pika, each found on two transects (Table 2).

TABLE 2

LONG-TERM RESPONSE BY RESIDENT WILDLIFE TO DISTURBANCES
INITIATED BY THE CANOL CRUDE OIL PIPELINE PROJECT, N.W.T. 1942-1945*

Site type	# of transects sampled	Woodland Caribou Trk[1]	Woodland Caribou Drop[2]	Moose Trk	Moose Drop	Dall's Sheep Trk	Dall's Sheep Drop	Large Game Trail	Arctic Ground Squirrel Dig[3]	Arctic Ground Squirrel Burw[4]	Pika Drop	Pika Res[5]	Other Small Mammals Drop	Other Small Mammals Burw	Red Fox Scat	Wolf Scat	Grizzly Bear Dig	Ptarmigan Drop	Wildlife Diversity
Control	33	2.6	1.5	8.0	1.7	3.5		2.0	1.0	1.6	1.0	1.0	6.7	12.8				4.0	7
Road	28	0.8	2.8	-1.3		3.0	4.3	0.5	7.8	0.5		1.5			1.0	1.2	2.5	3.1	9
False Start Road	3	1.5		1.0		1.0	3.0	1.0	22.0										4
Bladed Trail	16	8.3	0.0	-6.0	1.8	1.5-2.0			1.0	1.3			4.0	-3.0		1.0	1.0	1.2	8
Camp Yard	1																	2.0	1
Bulldozer Track	9	2.7	4.7	1.0	1.0	2.0		-2.0	2.0	0.5			42.0	20.0	2.0	1.0		2.7	8
Gravel Pit	25	3.7	1.3	-3.0	-1.0	4.0	3.7	1.0	5.0	1.0			2.0					1.8	6
Gravel Pit Access Road	9	4.2		-3.0	0.5	1.0	2.5		53.5	0.0								2.5	5
Oil Spill	7	2.5	1.0	1.0	1.0	4.0	1.0				1.0		8.0					5.0	6

* All values represent the mean change in wildlife sign from the control value: '-' designates a decline, '0.0' indicates no change and a positive value indicates an increase relative to the control.

[1] Trk = track [2] Drop = dropping [3] Dig = digging [4] Burw = burrow [5] Res = resident

By tallying the number of species and groups of animals, a rough index of the diversity in wildlife using each site can be derived. The diversity index perfect score would be 10 since 10 major categories of animals were recorded (Table 2). Controls averaged an index value of seven. Road, bladed trail and bulldozer track had greater diversity of animal use than controls while camp yards were the lowest with an index value of one (Table 2).

Vehicles, buildings, mile posts, telephone posts, bridges and earth spoil heaps provide elevated perches for resident raptors such as the Long-tailed Jaeger (*Stercorarius longicaudus*), Golden Eagle (*Aquila chrysaetos*), Gyrfalcon (*Falco rusticolus*) and Short-eared Owl (*Asio flammeus*).

DISCUSSION

Of the three assessment methods used, the transects provided the largest, most comprehensive data base. However, conclusions regarding the effect of CANOL disturbances on resident wildlife are based on all data sets.

Discussion of Small Mammal Trapline Results

Small mammal habitats have been created by the initial disturbances. Success rates were relatively low on all types of disturbed sites but were most similar to controls on bladed trails and bulldozer tracks, indicating that small mammals' populations have been least affected by these types of disturbances.

Long-tailed vole was the only small mammal not to be found on a disturbance, while, least chipmunk, meadow vole and heather vole were only found on disturbances (Table 1). Insufficient data exist to begin discussing trends, however, this does not suggest that certain species may be more tolerant to disturbance or even prefer disturbance habitats.

Discussion of Wildlife Sign Transect Results

Animal signs confirm the presence of a species in a particular area but do not

necessarily indicate what attracted the animal to the area, the type of use, or the amount of time spent there. In some cases, observational data were available to support a tentative hypothesis regarding timing and use but sufficient information was not collected to make firm conclusions. However, when viewed together, these data do provide information on species' presence/absence and relative intensity of use for the various sites.

Summer droppings of Ptarmigan were not detectable on the transects since the summer diet of lush, moist vegetation does not produce the dry, persistent droppings created by the winter diet of buds and twigs. The transect data therefore provide an indication of winter and fall use but not of spring or summer Ptarmigan activity.

The transect results can be viewed from two perspectives:

1) frequency of use of a site type (i.e. oil spill) as indicated by a particular type of animal sign (i.e. caribou tracks); and

2) the percentage of sites of a particular type having a given type of animal sign.

The first approach gives the magnitude of the differences among controls and disturbances (i.e.'control-corrected' values discussed above), whereas, the second provides an indication of site preference based solely on the type of disturbance.

Table 2 presents control-corrected values for all disturbances and shows the average control values for comparison. When sign was noted, values on roads were consistently higher than those of controls, with the exception of moose sign. Small mammal sign was lacking on roads while fox, wolf and bear left no evidence of use on controls. Resident pika were seen on the road but appeared to be resting in adjacent undisturbed areas.

False start road values were relatively low, with the exception of arctic ground squirrel diggings and sheep sign. Pika and small mammal sign, while evi

on control sites, was absent from false start roads. When sign of these animals was found on disturbances, the values were consistently higher than those of the controls.

On bladed trails, caribou sign was more frequent and moose sign much less common than on associated controls. The camp yard had higher values for Ptarmigan sign than did its control. A substantial difference was found between small mammal sign on bulldozer tracks and that on controls. Moose sign was less frequent in gravel pits than in controls but, when present, other animals consistently appeared to occur more frequently in the gravel pits. Gravel pit access roads had higher frequency of caribou tracks and ground squirrel diggings than did their controls. However, evidence of use by pika and other small mammals and game trails were absent.

Oil spills posed a special case since animal sign on these sites could be preserved for long periods of time. The waxy or tarry residue on the surface retains impressions left from animal passage and the chemically hostile substrate harbours few bacteria or fungi capable of decomposing droppings. Consequently, estimates of the intensity of use on these sites may appear much higher, in comparison to other site types, than they were in reality. The lack of vegetation on spills offers no opportunity for foraging and its associated digging activity. Ground squirrel burrowing sign was also absent.

A tally of the number of sites where sign was found, illustrates how frequently disturbances are used by animals in comparison with control sites (Table 2). The sign counts also provide some information regarding magnitude of use in the areas where they are found but do not necessarily reflect the sites' potential for use. Comparisons of the percentage of control sites with a particular sign and the percentage of disturbed sites with that sign suggest site preferences (Table 3).

Only one camp yard and three false start roads were sampled and the results

TABLE 3

FREQUENCY* OF RESIDENT WILDLIFE USE OF DISTURBANCES
INITIATED BY THE CANOL CRUDE OIL PIPELINE PROJECT, N.W.T.,1942-1945

Site type	Woodland Caribou		Moose		Dall's Sheep		Large Game	Arctic Ground Squirrel		Pika		Other Small Mammals		Red Fox	Wolf	Grizzly Bear	Ptarmigan
	Trk[1]	Drop[2]	Trk	Drop	Trk	Drop	Trail	Dig[3]	Burw[4]	Drop	Res[5]	Drop	Burw	Scat	Scat	Dig	Drop
Control	36	6	3	9	0	6	6	6	30	3	6	9	15	0	0	0	9
Road	29	14	11	0	4	21	7	18	4	0	4	0	0	4	14	7	32
False Start Road	67	0	33	0	33	67	33	33	0	0	0	0	0	0	0	0	0
Bladed Trail	50	13	6	25	13	19	0	19	19	0	0	13	6	0	6	13	31
Camp Yard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
Bulldozer Track	67	33	11	22	11	0	11	11	44	0	0	22	22	11	11	0	33
Gravel Pit	40	12	8	8	4	12	4	12	4	0	0	4	0	0	0	0	16
Gravel Pit Access Road	67	0	11	22	11	22	0	22	11	0	0	0	0	0	0	0	22
Oil Spill	57	14	14	29	14	14	0	0	0	14	0	14	0	0	0	0	14

* The number of transects with animal sign is expressed as a percentage of those sampled for each site type.

[1] Trk = track [2] Drop = dropping [3] Dig = digging [4] Burw = burrow [5] Res = resident

recorded for these site types are therefore inconclusive. In comparison with the controls, game trails, ground squirrel burrows and sign of pika and other small mammals appeared in a greater percentage of the bladed trail transects. Conversely, Dall's sheep droppings and pika sign were found in a smaller percentage of the bulldozer tracks. Gravel pit and gravel pit access roads had fewer records of game trails, ground squirrel trails, droppings and burrows, and sign of pikas and other small mammals than did controls. The percentage of the gravel pit access roads with caribou droppings was less than was recorded for the control sites, similarly, moose sign was less frequent in gravel pits than in undisturbed areas.

Summary Discussion

The trends apparent in the small mammal trapline and wildlife sign transect results are further supported by field observations. A summary of these trends and their relevance to resident wildlife responses to CANOL disturbances indicates that not all impacts have been negative in the long-term.

In areas with a limited number of sites suitable for arctic ground squirrels, disturbances have increased the amount of available habitat. This is particularly important in wet areas where the roads, false start roads, gravel pit access roads or gravel pit spoil heaps provide elevated, well-drained, and therefore dry sites, suitable for burrows. In areas where ground squirrel burrows were otherwise lacking, burrow entrance densities of as high as one in every two square meters were recorded on disturbed sites. Similar densities were also noted on naturally occurring elevated sites. Raised sites offer a broader field of view for ground squirrels on the lookout for approaching predators. All camp sites had relatively high populations of ground squirrels. For example, at Camp 80, on the Plains of Abraham, a local population of approximately 23 animals was recorded in 1979 and eight of these were young of the year. At least four adults had burrows beneath camp buildings and all of the CANOL structures were being used for cover. No

ground squirrels were seen in undisturbed areas on the Plains of Abraham.

Solitary bulls or small groups of bull caribou were observed most frequently approaching and utilizing disturbed sites. Groups of as many as 31 cows and 15 calves were noted using areas to within 0.5 km of disturbances. Only a small number of sightings of groups on disturbances were made and any conclusions require more information in order to test their reliability.

Caribou overwinter at lower elevations and none were sighted in the study are during the winter surveys. A small herd (8) was seen above R.M.P. 62 in late April 1979.

Caribou frequently altered their line of travel to follow a linear disturbanc This may have been a response to the greater ease of movement afforded by the smoother surfaces, relatively solid footing and lack of encumbering shrub cover on such features. Another important point is that the herbaceous and woody fora which often flourishes on these sites is composed of species that are rare or absent in the undisturbed areas. These species are often preferred food sources Furthermore, the view from an elevated surface is less restricted, an important factor where predators are concerned, and such areas are more open to the wind, thereby providing a cooler, relatively insect pest-free area.

Fewer data were collected for moose than for caribou, indicating that moose seldom used these disturbances. Unlike caribou, moose are primarily browsers an prefer to travel through dense shrub vegetation. They spend much of their time in wetlands and are therefore less concerned about sure footing. Their thick hi protect them from many of the smaller, biting insect pests that bother caribou. Also, heat stress is not a problem, since moose normally have easy access to wat bodies that remain cool throughout the summer. Therefore the firm, raised surfa created by the CANOL Project provide no great advantage for this species. The location of the road also may be an important factor since the wetlands were,

understandably, avoided by constructors whenever possible. Consequently, preferred moose habitat and CANOL disturbances tend to be mutually exclusive. A number of moose trails were seen during the winter in the western end of the study area. One of these extended along the road for several hundred meters but most crossed at various angles without significant directional changes.

Observational data indicate that sheep encountering roads will usually follow them, utilizing the roadbed for travel and sporadic grazing. This was noted most frequently in the Plains of Abraham area, where the flat plateau surface offers an unrestricted view enabling alert sheep to spot approaching predators with ample time to seek out the nearby refuge of the cliff walls. The road is the major disturbance in the Blue Mountain area where it generally follows the contours around the mountain. The winding route of the road, the great elevation change and the large number of draws provide many hidden approaches to predators for stalking prey. Sheep in this area were seen primarily on the steeper slopes above the road where there was ready access to escape routes, and they tended to move up and down the face of the slopes at right angles to the road rather than follow along it. At Pump Station No. 4, several separate bands of sheep moved into the camp yard during the day to feed on herbaceous and woody forage. In this case, the cliff immediately behind the camp provided an escape route.

During the winter, when travel routes intercept disturbances that offer less impediment to movement (a result of harder, thinner snow cover), sheep were often noted to alter course to follow these until conditions changed.

Foxes and wolves were frequently seen moving along the road. The increased range of view and reduced impediment to movement were undoubtedly important factors in this preference. However, the relatively high concentrations of prey species such as ground squirrels and Ptarmigan may also be an important contributing factor. The large Ptarmigan populations in the western half of the study area are probably

an important summer food source for resident canines.

Ptarmigan appear to be the most frequent users of the road, particularly in areas of shrub tundra. These ground dwelling birds seldom fly, preferring to ru from predators, and take flight only as a last resort. The road, gravel pit access roads, gravel pits, and in some cases, bladed trails provide sites where ground-level vegetation is often sparse and footing is firm. When such sites ar linear they offer ideal escape routes. Elevated disturbances also supply expose sources of crop gravel during the winter and dry sites for dust baths in the sum months. Observations in all seasons suggest that Ptarmigan strongly prefer dis- turbed sites to undisturbed areas. The only winter sighting of wildlife of any kind on the Plains of Abraham was a pair of Rock Ptarmigan browsing on *Salix alaxensis* along a bladed trail.

Rand (1946) noted Cliff Swallows along the CANOL route, however his easternmo record was at R.M.P. 218W (110 km west of Macmillan Pass) and "a colony of twelv to eighteen birds was seen under a new wooden bridge" at Ross River (1946:47). Currently, Cliff Swallows are only found in buildings and under bridges throughou the western portion of the study area and have extended their range as far east R.M.P. 208. Prior to 1945, these birds were nesting at Ross Post on long establ buildings and so were able to quickly colonize the newly created nesting sites p vided by the CANOL Project structures. Their current distribution suggests that they have yet to occupy CANOL tundra sites further to the east.

The swallows are only one example of a species able to utilize some of the mi habitats created by the Project above timberline. Other examples include the nu ous birds taken in the traps (Table 1). Their presence indicates that the local avifauna utilize many of the disturbances. More information is necessary in orde to clarify these interactions.

The presence of a bushytail woodrat at Camp 208 indicates that opportunities

exist for the transplanting of exotic species into these areas and with the subsequent establishment of breeding populations they could then compete with native species for the available resources.

CONCLUSIONS

It is evident that most of the disturbed areas associated with the CANOL Project are currently used by resident wildlife. However, not all disturbances were utilized to the same degree. Preferences may be related to a wide variety of local environmental characteristics, including snow distribution, snowpack characteristics, vegetation structure and composition, substrate characteristics and attitude of the disturbance. Not all species utilize disturbed sites to the same degree or for the same reasons. The effects of linear disturbances are similar in many ways to those of riparian systems. Both pass through otherwise homogeneous areas and thereby increase habitat diversity. Such 'edge' or 'ecotone' habitats can be areas of enhanced wildlife productivity (Odum 1971:157-159). However, disturbances such as oil spills and some gravel pits are essentially sterile and have reduced the amount of available habitat. A last point to consider is that these CANOL disturbances in 1979 were 34 to 37 years old and in an abandoned state. They must have had quite different characteristics shortly after their initiation. After abandonment there may well have been several years or more during which disturbances were avoided by wildlife. Reasons could include the relative sterility of these sites which supported little forage and the presence of something 'new' in the environment to which animals were as yet unaccustomed.

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